Gray Anatomy: The case of the missing “s”

One can prescribe a daily dose of 2 gray, but that does not make it right.

In the United States, one seldom hears of a dose of 2 grays. Apparently, the same is true on the Web. A recent query using Google.com found only 6 results for “a dose of 2 grays” (in quotes, emphasis added), whereas “a dose of 2 gray” yielded nearly 7,000 results (1, 2). Even an official from the International Commission on Radiation Units and Measurements (ICRU) responded to a recent request for clarification: “Gray is used when referring to one or more than one J/kg” (emphasis added) and cited ICRU Report 85 (3). Alas, Report 85—which defines the unit gray—does not address the question of plural forms (4). What, then, brought about this curious anomaly of grammar? When asked, many de-sensitized radiation oncologists and radiation physicists explain that the gray is like *deer*: you can have one deer or two deer, but not three *deers*. However, the existence of a few (relatively rare) irregular plurals in the whole of English hardly seems proof or explanation that another word should be treated as such. This is especially true in light of the long-held belief among etymologists that “unchanged plural nouns” in English arose as corruptions of words adopted from other languages (5), which is clearly not the case for the gray. Further, given that the gray is a standardized unit, carefully defined and officially incorporated into the International System of Units (SI), one might reasonably expect a more satisfactory justification of the alleged syntactical deviance.

In fact, the story of the gray is one of standardization (6). The General Conference of Weights and Measures (CGPM) was established in 1875 and began formally promoting what would become the International System of Units (SI) by 1960, including familiar entities such as the meter and the kilogram. Units related to radiation lagged behind this movement, with persistence of the non-SI rem, rad, röntgen, and curie. By 1970 the British Committee on Radiation Units and Measurements (BCRU) and the ICRU were calling for adoption of standardized measurements. In 1973, joules per kilogram (J/kg) was proposed for the standard dose of absorbed energy by the BCRU and then by the ICRU. In 1975 CGPM gave its blessing to a special name for the unit J/kg when referring to ionizing radiation, calling it the gray, after Louis Harold Gray, who, among other things, had developed the concept of relative biological effectiveness (RBE) and defined a unit for radiation as absorbed energy (6, 7).

Thus, Professor Gray joined the illustrious company of Joule, Kelvin, Ampere, Tesla, Watt, Ohm, and Pascal, all honored with an SI unit name. However, all of these other SI units follow typical pluralization in English: e.g., amperes, watts, and joules. The BIPM itself publishes an extensive brochure on SI units, which remains silent on pluralization of unit names but states, simply: “Unit names are … treated like ordinary nouns” (8). An SI style guide produced by the Society of Petroleum Engineers, on the other hand, explicitly states that SI units “form their

plurals in the usual manner (9).” The National Institute of Standards and Technology (NIST) “coordinates Federal Government policy on … the use of the SI by U.S. industry and the public [and also] provides official U.S. representation in the [CGPM].” NIST publishes a definitive guide on SI usage, wherein it is stated under Section 9.2: “Plural unit names are used when they are required by the rules of English grammar. They are normally formed regularly, for example, “henries” is the plural of henry” (10)[2].

Despite the popular spoken use of gray as an irregular plural, several authoritative sources use grays when the word is written out. Alan Jennings, a member of the Radiology History and Heritage Charitable Trust in the U.K. wrote an article in 1984 detailing the history of radiation units and of efforts ongoing at that time to promote their widespread adoption internationally (6, 11). In his history, Jennings uses the plural form grays. Similarly, publications from the BIPM spanning at least 1986 to 2013 also use grays (12, 13). And in 2015, web pages sponsored by the U.S. Nuclear Regulatory Commission and the Department of Energy are also each found to use the plural grays (14, 15).

At the bottom of the case of the missing “s”, it would appear we have a simple corruption adopted in casual speech. We argue that correct usage of this scientific term in plural is grays, consistent with the overwhelming majority of English nouns, as well as SI unit convention. We submit that prescriptions should therefore be made in grays for the sake of such consistency, while noting the words of Ralph Waldo Emerson:

> “A foolish consistency is the hobgoblin of little minds, adored by little statesmen and philosophers and divines. With consistency a great soul has simply nothing to do. He may as well concern himself with his shadow on the wall” (16).

It is for the reader to determine which consistency is the more foolish: formal SI style or the common parlance of our field.

[2] The NIST guide further lists only three exceptions for unit names ending in an *s* sound: lux, hertz, and siemens, which are the same for singular and plural.

Table: Additional style rules for SI units

Rule	Correct	Not correct
Unit names start with a lowercase letter.	A length of 24 meters A dose of 30 grays	A length of 24 Meters A dose of 30 Grays
Eponymous unit symbols have a single capital letter. Non-eponymous unit symbols are lowercase.*	24 m 30 Gy 60 kg	24 M 30 gy 60 Kg ^
Unit symbols are mathematical entities and are not pluralized.	24 m 30 Gy	24 ms † 30 Gys
Unit names are pluralized only if the numerical value is >1.	A length of 0.25 meter A dose of 0.8 gray	A length of 0.25 meters A dose of 0.8 grays
Numbers and unit symbols are separated by a space. This holds even if used as a one-thought modifier before a noun.	24 m 30 Gy A 50 m race A 10 Gy boost	24m 30Gy A 50-m race A 10-Gy boost
A hyphen may separate a number and unit name if used as a one-thought modifier before a noun.	A 50-meter race A 10-gray boost	A 50-m race A 10-Gy boost

Adapted from Special Publication 811 (10) of the National Institute of Standards and Technology (NIST).
* Except L is acceptable for liter to avoid confusion between the lowercase l and 1.
^ This indicates 60 kelvin-grams, not the intended 60 kilograms.
† This indicates 24 milliseconds, not the intended 24 meters.

Acknowledgments

The authors thank Vitali Moiseenko, Jerry Battista, and James Murphy for helpful discussions and Elizabeth Gentry of the National Institute of Standards and Technology for her responsiveness and detailed assistance with our inquiries.

References

1. Google. “a dose of 2 gray” - Google Search.

2. Google. “a dose of 2 grays” - Google Search.

3. International Commission on Radiation Units & Measurements (ICRU). A question on the unit Gy. Personal Communication. 2014.

4. The International Commission on Radiation Units and Measurements. Report 85. *J. ICRU*. 2011;11:NP–NP.

5. Palmer AS. *Folk-etymology: A Dictionary of Verbal Corruptions Or Words Perverted in Form Or Meaning, by False Derivation Or Mistaken Analogy*. George Bell and sons; 1882.

6. Jennings WA. When did you last see your rontgen?-the SI units and their use. *Phys. Med. Biol.* 1984;29:131.

7. Gupta SV. *Units of Measurement: Past, Present and Future. International System of Units*. Springer Science & Business Media; 2009.

8. Bureau International des Poids et Mesures (BIPM). SI Brochure: The International System of Units (SI) [8th edition, 2006; updated in 2014]. 2014.

9. Society of Petroleum Engineers. Style Guide. 2014.

10. Thompson A, Taylor. NIST: Special Publication 811 (Extended Contents). 2015.

11. Jennings, WA. A Brief History of the Evolution of Medical Physics in the United Kingdom in the Twentieth Century. *Invis. Light J. Radiol. Hist. Herit. Charit. Trust*. 2004;20.

12. Allisy, A. The BIPM Ionizing Radiation Section (1960-1985). *Bur. Int. Poids Mes.* 1986.

13. Kessler C, Burns DT, Delaunay F, *et al.* Key comparison BIPM.RI(I)-K4 of the absorbed dose to water standards of the LNE–LNHB, France and the BIPM in 60 Co gamma radiation. *Metrologia*. 2013;50:06019.

14. United States Nuclear Regulatory Commission. NRC: 10 CFR 20.1004 Units of radiation dose. 2015.

15. Oak Ridge Institute for Science and Education, established by the U.S. Department of Energy. Quick Reference Information - Radiation. 2015.

16. Emerson RW. *Self-Reliance and Other Essays*. Courier Corporation; 2012.